SEDETEP

Transformation of the Spanish Operation Research Simulation Working Environment

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ABSTRACT

The Spanish Navy Operations Research Laboratory is developing a project called SEDETEP ("Synthetic Environments DEvelopment Tools Evaluation Project"). The objective of this project is to create an Operation Research Simulation Working Environment (ORSWE) to perform simulation projects in an optimized manner, allowing analysts to reuse assets, minimize development costs and use more effectively the human resources assigned and the know-how generated.

1. REPORT DATE **01 SEP 2006**	2. REPORT TYPE **N/A**	3. DATES COVERED **-**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
SEDETEP Transformation of the Spanish Operation Research Simulation Working Environment	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER

7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Spanish Navy Operations Research Laboratory (Gimo) Arturo Soria 287 28033 Madrid - Spain**	8. PERFORMING ORGANIZATION REPORT NUMBER

9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES **See also ADM002053., The original document contains color images.**

14. ABSTRACT

15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**UU**	**40**	

The ORSWE will provide a process that will help to design, perform, and analyze Operation Research experiments and also, by means of an agreed formal characterization of resources, to avoid semantic ambiguity enabling reusability and resource sharing . Furthermore, the use of standards will foster interoperability.

The SEDEP ("Synthetic Environment Development and Exploitation Process") methodology, developed by the Western European Union EUCLID RTP 11.13 project (based on the FEDEP standard), has been adapted to create a process suitable for two different user profiles: M&S Software Developer and Operation Research Analysts.

To support this process, ORSWE will provide a comprehensive set of tools. To develop this, we have considered the prototype set of tools developed by EUCLID RTP 11.13, as well as the most relevant emerging technologies such as Model Driven Architecture (MDA), ontologies and the Semantic Web.

This paper describes the activities undertaken as part of the SEDETEP project and how the ORSWE will enable the transformation of the Spanish Navy Operations Research Laboratory into a more efficient provider of decision support for the Spanish Navy.

1. INTRODUCTION

1.1. Background

This paper intents to describe the SEDETEP (**S**ynthetic **E**nvironments **DE**velopment **T**ools **E**valuation **P**roject**)** project. SEDETEP is under development by the Spanish Navy Operations Research Laboratory (GIMO). The main mission of GIMO is to provide the Spanish Navy with scientific decisions support. For this task, GIMO uses the classical OR tools like Mathematical Programming, Statistics, Heuristics or Simulation.

Simulation is one of the most important and used OR tools. It is mainly employed when other tools are not available or suitable for the problem. Usually, when the problem in hand requires the modeling of complex environments, in which too much simplification is needed to develop a mathematical model. One drawback of the use of simulation in OR projects is that it does not provide solutions, as other methods do, but it allows comparison of alternatives.

The SEDETEP has duration of two years. It started in December 2004 and it is scheduled to finish in December 2006. It is under contract with INDRA Sistemas, SA. There is a very tight relationship between this project and the NATO MSG-042 task group on the definition of a "Framework for Simulation Resources Reusability" (FSRR).

The initial motivation for this project was the lack of a methodological and systematical approach for the development of OR projects in the GIMO. Every problem was faced with little consideration for previously gathered know-how and already developed and owned simulation resources. GIMO did not have any kind of working environment for designing, running and analyzing experiments based on simulation. Usually, the simulators developed by contractors to tackle a particular problem, like, for example, anti-ship-missile-defense (ASMD), were different and non-compatible with others created to make experiments in very similar fields.

SEDETEP should provide a Synthetic Environment Development Methodology and an Operation Research Simulation Working Environment (ORSWE) for GIMO with these capabilities:

•   Allow reuse of simulation resources (models, scenarios, components...)

•   Assist in the development of simulation models and components

- Help in the design, execution and analysis of OR experiments

- Provide tools to avoid semantic ambiguity at resource level and to define an agreed formal semantic definitions of resources

- Enable interoperability using standards

To build this working environment, several initiatives in this field have been considered, like the EUCLID RTP11.13 studies and new technologies on ontologies. These approach aims to give this research project an innovative character.

1.2. Topics Covered

Some of the most important topics covered by SEDETEP are enumerated below:

- Interoperability among simulation resources.

- Development and Exploitation of Synthetic Environments

- Development process methodology

- Use on Ontologies for defining, developing and reusing resources

- Use of the Model Driven Architecture (MDA) for reusing platform independent resources.

1.3. Deliverables

The deliverables of the SEDETEP are:

- A Process to develop Operation Research projects, especially those in which Synthetic Environments are implied.

- An Environment composed by a set of tools that covers the whole life cycle of Operations Research projects and a repository that will be the integrating piece of the rest of tools and the container of the resources.

2. OBJECTIVES

The main objective of SEDETEP is to build a new working environment to develop Operations Research projects (ORSWE) according with a development and exploitation methodology.

To reach this primary objective the following four subobjetives have been defined:

- Analyze Euclid RTP11.13 works in order to apply the knowledge obtained to the national project. Specially focusing on the SEDEP process ("Synthetic Environment Development & Exploitation Process") based on HLA-FEDEP.

- Application of the Ontologies paradigm to Simulation

- Application of the MDA architecture to develop of synthetic environments under the SEDEP process

- Coordination with the RTO NATO MSG–042. This task group intends to establish a common framework to foster simulation resources sharing across the Alliance and to manage them efficiently avoiding duplicated efforts.

3. SEDETEP APPROACH

Due to the great number of actors involved in a simulation project, the SEDETEP developing team decided to focus only in two specific kinds of users: the Operations Research Analyst and the M&S Software Developer. These two categories of users will be explained in more detail further in this paper.

The approach to develop the SEDETEP has been, first, to analyze the tools proposed by EUCLID RTP 11.13 to support the SEDEP process in order to determine which of them, if any, could be reused to build the ORSWE. It was planned that, in case these tool would not cover the needs and requirements of the Spanish Navy Operations Research Laboratory and, therefore, the Spanish Ministry of Defense, a new set of tools would have to be acquired to build the ORSWE. This last alternative would be costly in time and effort because the integration between all the tools acquired would have to be made with specific wrappers. This new set of tools would have to be selected attending to the capabilities they cover and their easy integration with the rest of the environment tools.

Second objective was to determine the convenience of applying the SEDEP process for the ORSWE and the necessary tailoring to adapt it to the project needs.

As general objective, it is the aim of this project to use some of the new technologies and study how applies to the simulation field.

3.1. The Users

For the scope of this project, the Synthetic Environment (SE) users are classified in three groups:

* "Problem Setter": Those who have problems that SE could help to solve. The requirements of the Problem Setter are essential. They have to be defined using the domain vocabulary of the expert.

  These users will provide the Problem Solver the requirements about the scenario generation, that is, the behavior the user wants to give to the elements of the scenario for the experiments; the SE control; the interoperability needs; the SE GUI

* "Problem Solver": Those who help the Problem Setter to define the problem. The Problem Solver applies past experiences and know-how to perform these tasks. The Problem Solver should use the content of the repository to reuse those resources that has been implemented previously.

  He/she has to keep in contact with the Problem Setter to agree on a set of requirements for the capabilities of the future system.

* "Developer": Those who implement and develop SE. It is essential for the "Developer" to understand what he/she has to implement. If the Problem Solver asks for models that do not exist in the repository, he/she should provide to the Developer with the information necessary to create this model. The communication between Problem Solver and Developer has to be clear and unambiguous.

Even thought, three different categories of users have been identified, all the efforts of this project will be focus in the Problem Solver or Operations Research Analyst and the Developer. The Problem Setter has been discarded because we consider these two responsible of generating the SE and, thus, those which will use more profusely the ORSWE.

There are also a great variety of OR problems, but this project will focus only on Mission Rehearsal and Simulation Based Acquisition.

3.2. EUCLID RTP 11.13 Analysis

EUCLID RTP 11.13 was a very important European project and, in principle, it offered us the opportunity to reuse the tools created during the project to support the SEDEP process.

The main objectives of the EUCLID RTP 11.13 were to provide a useful methodology (SEDEP), based in FEDEP, for the development of synthetic environments and to offer the people involved in the generation of this kind of environments the possibility to reuse the knowledge acquired as well as the job performed in previous projects.

To enable the implantation of this methodology and to fulfill the reusability objective as much as possible a set of tools was developed to support the different activities within SEDEP.

The repository was a key part of these tools and the core of the environment. This repository was in charge of storing the information generated during the project, to provide the data interchange among tools and to allow reusing of resources in other projects.

The tools were grouped taking into account the SEDEP step in which they had application. There are seven steps identified within SEDEP and the analysis was done according with this classification.

As a general conclusion, SEDEP is considered a great initiative because it is a new methodology (based on FEDEP) that is useful as a guideline for the SE generation what make easier the simulation community work. For the same reason it is necessary to highlight the huge effort done by the companies that participate in the EUCLID RTP 11.13 project to provide to this methodology with a collection of tools to support it.

It is necessary to take into account than these tools generated during the EUCLID RTP 11.13 project are prototypes and, some of them have not completely developed their functionality or they have not passed an exhaustive test, verification and validation phase. It would be necessary to perform a refinement process if it is intended to use these tools for SE projects.

As a result of the analysis the following drawbacks were found:

- It would be desirable to have an installation tool in order to assist the user of this activity.

- A tool that manages effectively the repository would be very valuable to obtain data stored on it and to enable the load and download of certain kind of files (zip, rar, data base files, etc.). Currently, this is not supported directly and it would be essential for the maintenance of a repository that intends to be useful. It would be also very important to include powerful searching options that enable the information retrieve.

- The tools are based on commercial software. This increases the price of the final product because it is a wide set of tools and it complicates the tool maintenance. It would be necessary to redefine the way in which COTS tools are used within EUCLID RTP 11.13, trying to minimize the number of tools to acquire while maximizing the number of SEDEP steps that each tool covers.

- A logger for collecting data produced during the federation's execution is not provided. This tool is especially important because the analysis and evaluation step of SEDEP is not completely supported.

- If the complexity and number of resources of the project on hand increased the performance of the whole environment decreased dramatically because the amount of information to be transferred from step to step is too high for the system. This requires a lot of reading and conversion and, in the special case of distributed simulation, would become a huge problem even more if the network infrastructures do not have high band-width.

- Although the system allows sharing of information in a distributed manner, team-work is not supported. The environment should allow several people to work on the same activity without a loss of consistency in the information. To accomplish this, the development team should be forced to follow a strict planning based in SEDEP.

- There is a deep gap in the step 4 (Implement Federation) because there are not enough tools to support it. It is considered the use of MDA tools and resource libraries would allow reaching a higher level of abstraction and reusability making easier the implementation in different platforms or in different projects.

For these reasons it was taken the decision of not to use the tools provided by EUCLID RTP 11.13 but it was considered that it would be very interesting to take advantage of the process defined in the same project, the SEDEP. In order to reuse this process, an adaptation of SEDEP will be done for the Spanish MoD and a new set of tools to cover the whole life cycle defined by this adapted process will be acquired.

3.3. ORSWE Tools

To configure the working environment ORSWE several COTS have been acquired attending to the features needed to develop synthetic environments projects.

The list of the kind of tools is:

- An Ontology Development and Exploitation tool

  It is needed by the Problem Solver to express the application ontology that defines the problem to solve. When a problem is declared by Problem Setter, many concepts and domain terms arise through the analysis. These concepts will be used, as well, as resources searching criteria.

  This ontology will be based on the Problem Setter requirements, expert entries and ontologies previously created.

  The capacity to obtain these concepts and establish relationships among them offers a very valuable tool for the problem definition and its understanding along the project development to all the people involved on it. It will be used to describe without ambiguities the problem to be solved using ontologies.

- A Requirement Management tool

  A tool that helps the Problem Solver to collect all the requirements, organize them and trace the test cases related to these requirements through the whole life cycle.

- A Model Analysis and Design tool

  It is used by Developer to design and to document the models to be used in the simulation.

  The main criterion for the selection of this tool was that supports the Model Driven Architecture (MDA). This objective was to take advantage of the Platform Independent Model (PIM) and the Platform Specific Model (PSM) features. These allow two different levels of abstraction that foster the reusability due to the fact that PIMs are potentially easy to be reused.

- A Experiment Design tool

  It is a statistical tool that allows the OR analyst (Problem Solver) to design experiments to be performed by the simulator (federation).

- A Scenario Generation tool

  It helps the OR Analyst to build the scenario based on the requirements and the application ontology and to implement the experiments. This task may require a previous experiment test phase in which a small number runs are performed to verify that the experiment is properly designed.

- A Data Analysis tool

  Statistical tool used by OR Analyst to analyze the results from the experiments to produce recommendations for the decisions maker.

It can also be used by the Developer to test particular models develop under demand of the Problem Solver.

- A Database Management tool

    It is used to implement the Repository. It takes care of storing all outputs of the tools that will be needed as inputs of other tools.

- Asset Characterization Tool

    An agreed characterization of the resources is necessary to know exactly which kind of resources is searched. It is based on Ontologies and the Semantic Portals.

- Synthetic Environment Management Tool

    It is a development tool that guides the Problem Solver and Developer along the whole process

3.4. The Repository

The repository will be used as the intermediate tool in which input and output data to and from the tools can be retrieved and stored.

It uses XML entries to normalize inputs and outputs. This way the data that flow through the system is independent from the tools that produce or consume them. The purpose is to make the ORSWE flexible enough, independent from the particular set of tools selected, and not a format dependent system.

This repository allows the users to share the information about projects and to use models and simulators previously documented, tested and verified.

It will be composed of two different, but related, parts:

- The Public Repository

    It is the part of the repository in which there is information about the resources that have been identified as able to be shared.

    The catalog offers a set of metadata that allow searching.

    This repository will participate in the MSG-042 demonstration of the concept. This demonstration interconnects several repositories. It intends to show that reusability is not only a technical problem but other factors impede the share of simulation resources.

- The Private Repository

    It is the part of the repository in which the Problem Solver and Developer work (the ORSWE). No resources of this part will be public unless a specific upload process is executed.

4. SEDEP ADAPTATION

SEDEP is explained in EUCLID RTP 11.13 as a set of elements within a hierarchy. The top level is split in eight Steps, which are decomposed on Activities, and these ones in Tasks. These tasks have associated some checking lists.

In the adapted process for ORSWE some activities of the original SEDEP have been disregarded and other ones have been added. This way, the selected activities are the ones that, under the point of view of the project team, were more relevant to the simulation community of the Spanish MoD.

For example, the adapted process for the OR Analyst (Problem Solver) consists of:

- Step 0: Analyze User Needs

- Step 1: Define User Requirements

- Step 2: Define System Requirements

- Step 3: Define Experiment Design

- Step 4: Implement Scenario

- Step 5: Test Scenario

- Step 6: Execute Scenario

- Step 7: Evaluate Scenario

This is an iterative process, as it is usual in many other software engineering methodologies. The results obtained in each step help to refine the inputs of new iterations.

Figure 1 shows the information flows among the steps and the tools that support each one. Step 0 does not appear in the figure because the activities of this step do not require any kind of tool.
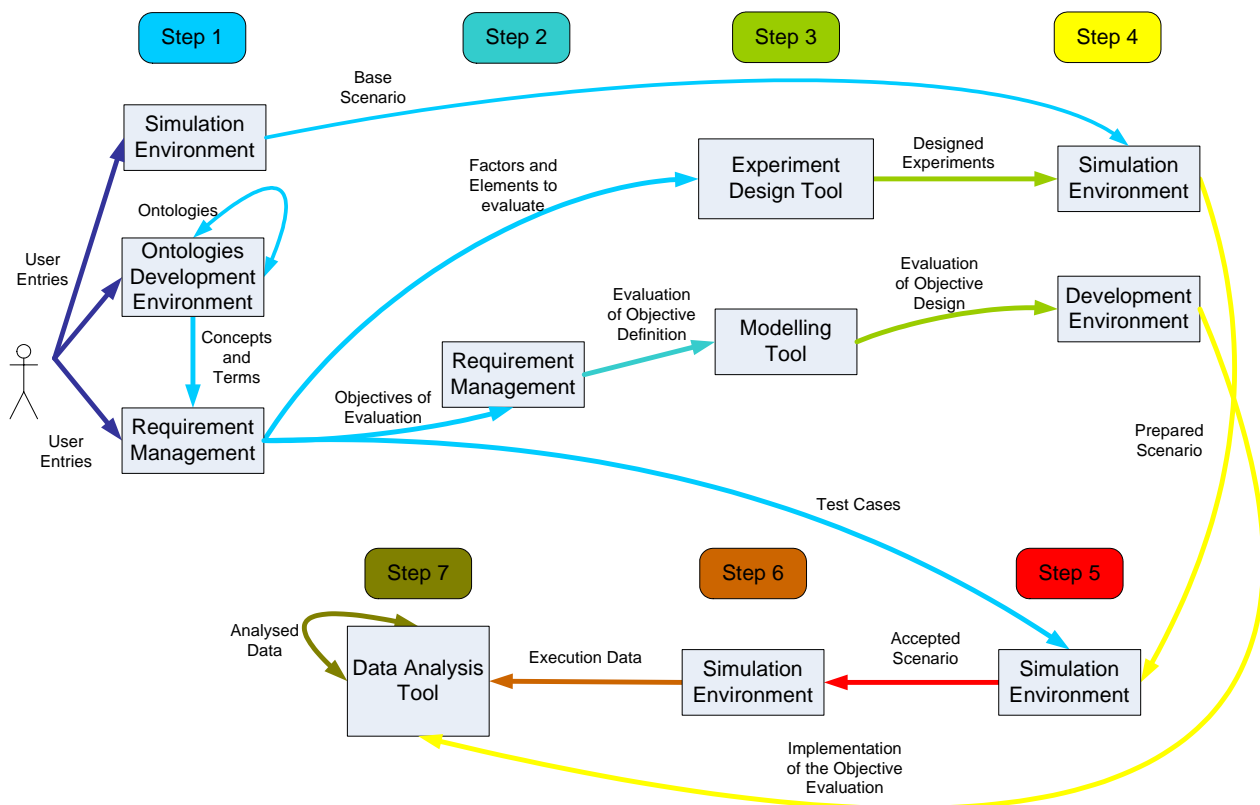
Figure 1. – OR Analysts Process

4.1. STEP 0: Analyze User Needs

DESCRIPTION

- Define and analyze the user needs to understand:

  - The results Synthetic Environment should provide

- • The concepts that will be used

- • The purpose of the current iteration of the process

- • Reusable resources will be searched in the repository to reduce cost and risk due to the reusability of previous projects know-how and resources.

- • The OR Analyst will plan the project according with objectives drawn from the user requirements.

ACTIVITIES

- • To analyze the user entries (documents, contracts, etc.)

- • To search data about existing SE.

- • To plan the project.

4.2. STEP 1: Define User Requirements

DESCRIPTION

- • Taking as starting point the User Needs the OR Analyst (Problem Solver) will provide a comprehensive description of what the Problem Setter requires.

- • Problem Setter and Problem Solver should work together to define:

  - • The problem application ontology. For this they should use, if available, concepts previously defined and agreed. Also, the help of Domain Experts could be necessary.

  - • The project requirements

  - • The Base Scenario

  - • The Evaluation Objectives. These are the objectives the Problem Setter wants the final system to achieve.

ACTIVITIES

- • To develop an Application Ontology.

- • To produce the User Requirements.

- • To develop the Base Scenario.

- • To define the Evaluation Objectives.

4.3. STEP 2: Define System Requirements

DESCRIPTION

- • The Problem Solver defines the Evaluation Requirements. These specify criteria, methods, algorithms, etc. that state how to test that the Evaluation Objectives have been achieved.

ACTIVITIES

- • To define the Evaluation Requirements.

4.4. STEP 3: Define Experiment Design

DESCRIPTION

- To obtain an optimum and relevant set of Experiments to solve the problem.

- To elaborate the Test Plan that allows to check if each Evaluation Objective is been considered.

- To perform a high level design of the Evaluation Objectives.

ACTIVITIES

- To develop the Experiments Design.

- To elaborate the Test Plan.

- To design the Evaluation Objectives.

4.5. STEP 4: Implement Scenario

DESCRIPTION

- Once the Experiment Design has been obtained, a set of experiments, to be executed over the Base Scenario, will be created. Each experiment should specify the value of the parameters of the scenario, the variables to be recorded and numbers of runs needed.

- On the other hand, Evaluation Objectives will be implemented. The purpose of this activity is to implement and test everything related with the storage and analysis of the evaluation data. It could include the data processing software implementation, the algorithms to transform into the specific formats of the tools, the additional hardware to record data, for instance, video/audio record devices, questionnaires and checklists hardcopies, etc.

- When it could be possible, algorithms implementations and data processing software should be reused.

- A complete test of the evaluation data collection and the analysis method has to be done in this step to carry out modifications or adjustments, when it is needed.

ACTIVITIES

- To Build the Scenario.

- To implement the Evaluation Objectives.

4.6. STEP 5: Test Scenario

DESCRIPTION

- This step objective is to test that the scenario has been built according with the requirements and furthermore that the simulation makes sense, it passes the gut-test. Moreover, this test also proof whether all elements of the scenario are integrated and necessary.

ACTIVITIES

- Test the Scenario.

4.7. STEP 6: Execute Scenario

DESCRIPTION

- To execute the Scenario/s.
- To collect data in order to perform the Evaluation.

ACTIVITIES

- To execute the Scenario.
- To prepare the experiment output data.
- To collect additional evaluation data.

4.8. STEP 7: Evaluate Scenario

DESCRIPTION

- To analyze the collected data and generate recommendations.
- These results allow to the Problem Solver decide if the problem has been solve properly or if it is necessary another iteration of the process.

ACTIVITIES

- To Analyze and evaluate the experiment output data.
- To infer conclusions from the experiment results.

5. CONCLUSIONS AND FUTURE WORK

The transformation this project is performing is focused on the way the Navy Operations Research Laboratory face up projects to solve.

The ORSWE environment has been designed flexible enough to take into account the needs of each type of user.

A new manner to organize the available resources allows GIMO a faster and cheaper response due to the reusability of models and simulations previously developed and stored in a repository ready to use.

A common repository in which store and share resources is the core around the entire environment will work.

A methodology (SEDEP) supported by a set of tools drives the development of projects making it easier for the Developer to reuse a model than to build it from scratch.

This is a research project that aims to expand its results along the whole MoD in order to support the simulation community through the complete organization.

The reduction of time and costs through the reusability of resources and know-how is a target of any organization to be competitive and effective and it was the objective of SEDETEP.

Transforming Training and Experimentation Through Modelling and Simulation

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Introduction
GIMO
SEDETEP
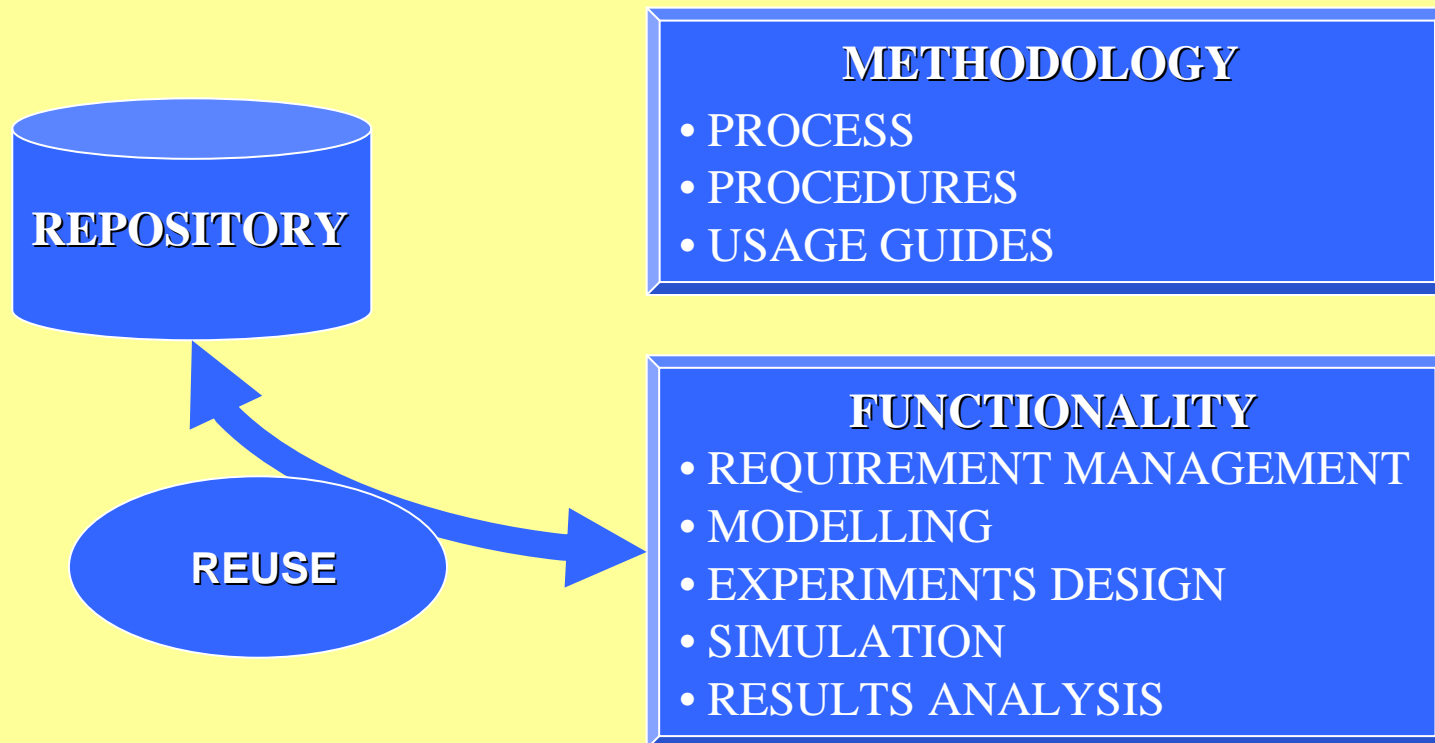
Operation Research Simulation Working Environment
SEDETEP Approach
SEDEP Adaptation
Conclusions

- **GIMO is the Operation Research Center of the Spanish Navy**
- **The main mission of GIMO is to provide the Spanish Navy with scientific decisions support**
- **GIMO uses the classical OR tools**
  - Mathematical Programming
  - Statistics
  - Heuristics
  - SIMULATION
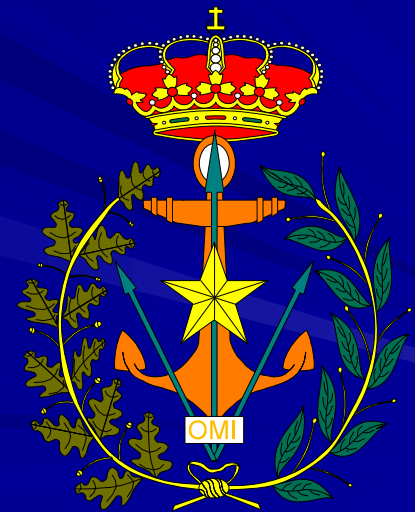
Simulation as OR Tool

- **SIMULATION is one of the most important and used OR tools**
- **It is used when other tools are not available or suitable for the problem. Usually for complex environments (too much simplification needed for the mathematical model)**
- **It does not provide solutions but allows the comparison of alternatives**

Simulation Problems at GIMO

- **Different simulators for similar problems**
- **Need to start from scratch**
- **There is not a fixed methodology**

- **No reusability between them**
- **We paid twice for the same work**

SEDETEP

Synthetic Environments DEvelopment Tools Evaluation Project

Duration	2 years (DEC 2004 – DEC 2006)
Participation	GIMO (Spanish Navy Operations Research Laboratory) INDRA Sistemas ISDEFE
Technology Areas	• Interoperability • Synthetic Environments • SEDEP development process • Ontologies • Model Driven Architecture (MDA)

Introduction
   GIMO
   SEDETEP

Operation Research Simulation Working Environment

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Conclusions

**ORSWE
OPERATION RESEARCH SIMULATION WORKING ENVIRONMENT**

REPOSITORY

REUSE

METHODOLOGY

- PROCESS
- PROCEDURES
- USAGE GUIDES

FUNCTIONALITY

- REQUIREMENT MANAGEMENT
- MODELLING
- EXPERIMENTS DESIGN
- SIMULATION
- RESULTS ANALYSIS

DECISION TAKING SUPPORT

Capabilities Required for the GIMO

■ **The** ORSWE **should:**

Allow **REUSE** of simulation **RESOURCES**
(models, scenarios, components...)

Assist in the **DEVELOPMENT** of
Simulation **MODELS** and **COMPONENTS**

Help in design, perform and analyze **OR EXPERIMENTS**

AVOID semantic **AMBIGUITY** at resources level.
AGREED formal semantic **DEFINITIONS** of resources

BE an **INTEROPERABILITY** enabler
Through the use of Standards

Introduction
   GIMO
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Operation Research Simulation Working
Environment

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Conclusions

M&S Developers

User Profiles (who for)

OR Analysts

Capabilities:

⇨ **Create** new Resources

⇨ **Modify** existing Resources in order to adapt them to the experiment's needs

⇨ Have a **Global Visibility** of existing resources

⇨ Perform Component **Integration & Testing**

Capabilities:

⇨ Have a **Global Visibility** of existing resources

⇨ **Reuse** Synthetic Environment **Resources**

⇨ Design & Perform **Experiments**

⇨ **Analyze** & **Evaluate** Experiments' outputs

⇨ **Decisions Support** according with the results

⇨ **Demand** development of new Model

Kind of Problems (**what for**)

✧ **SBA**
✧ **Mission Rehearsal**

EUCLID RTP 11.13 Analysis

- **This was a very important initiative that offers us the opportunity to reuse the tools created to support the SEDEP process**

- **This tools were prototypes. It would be necessary to accomplish a refinement process to make them operatives**

- **SEDEP is a valid process but it has to be adapted to the Ministry of Defense needs**

- **It was taken the decision of use this process but do not use the tools that support it.**

- **A new set of tools will be acquired in order to cover the process life cycle necessary to reach the SEDETEP objectives**
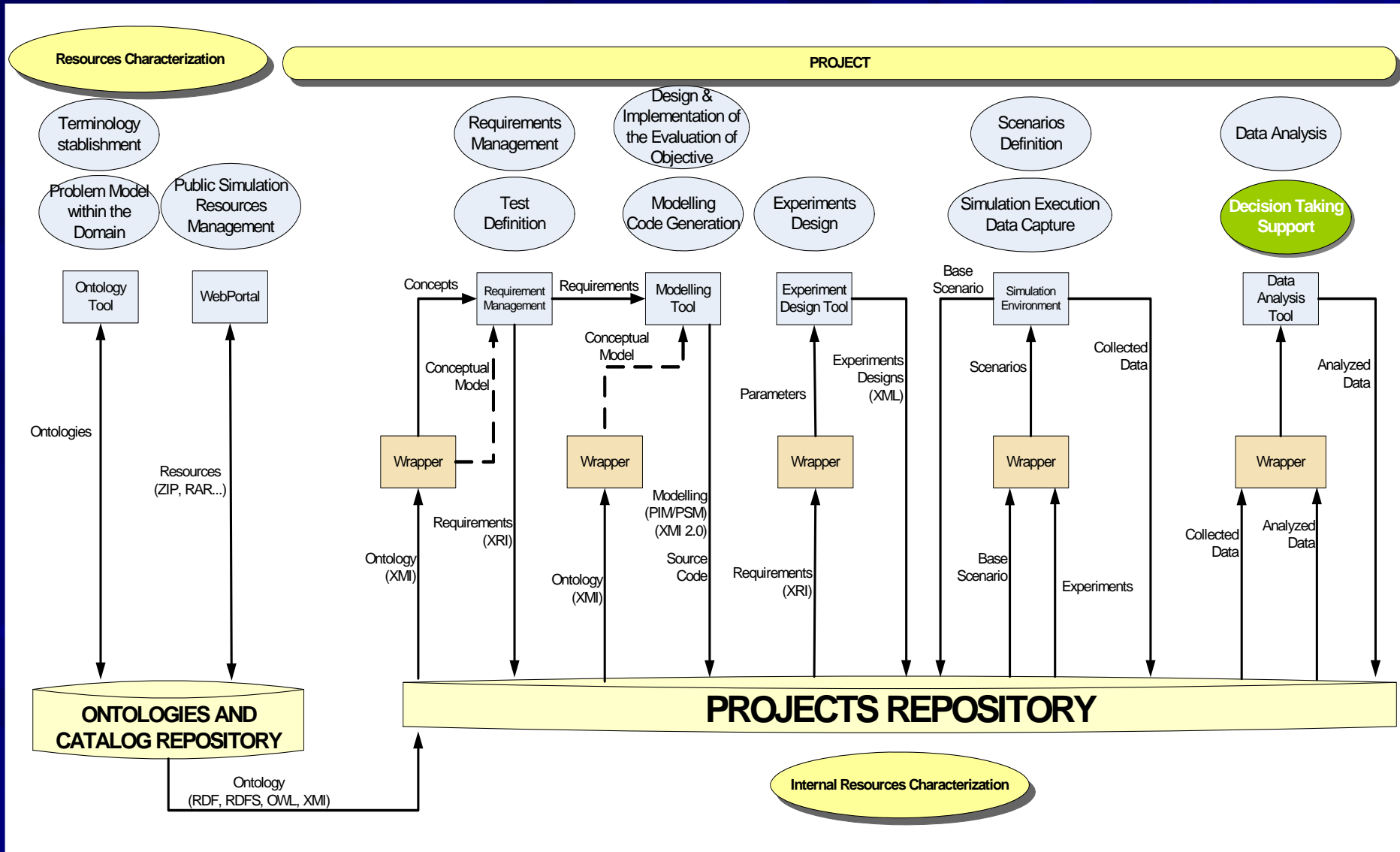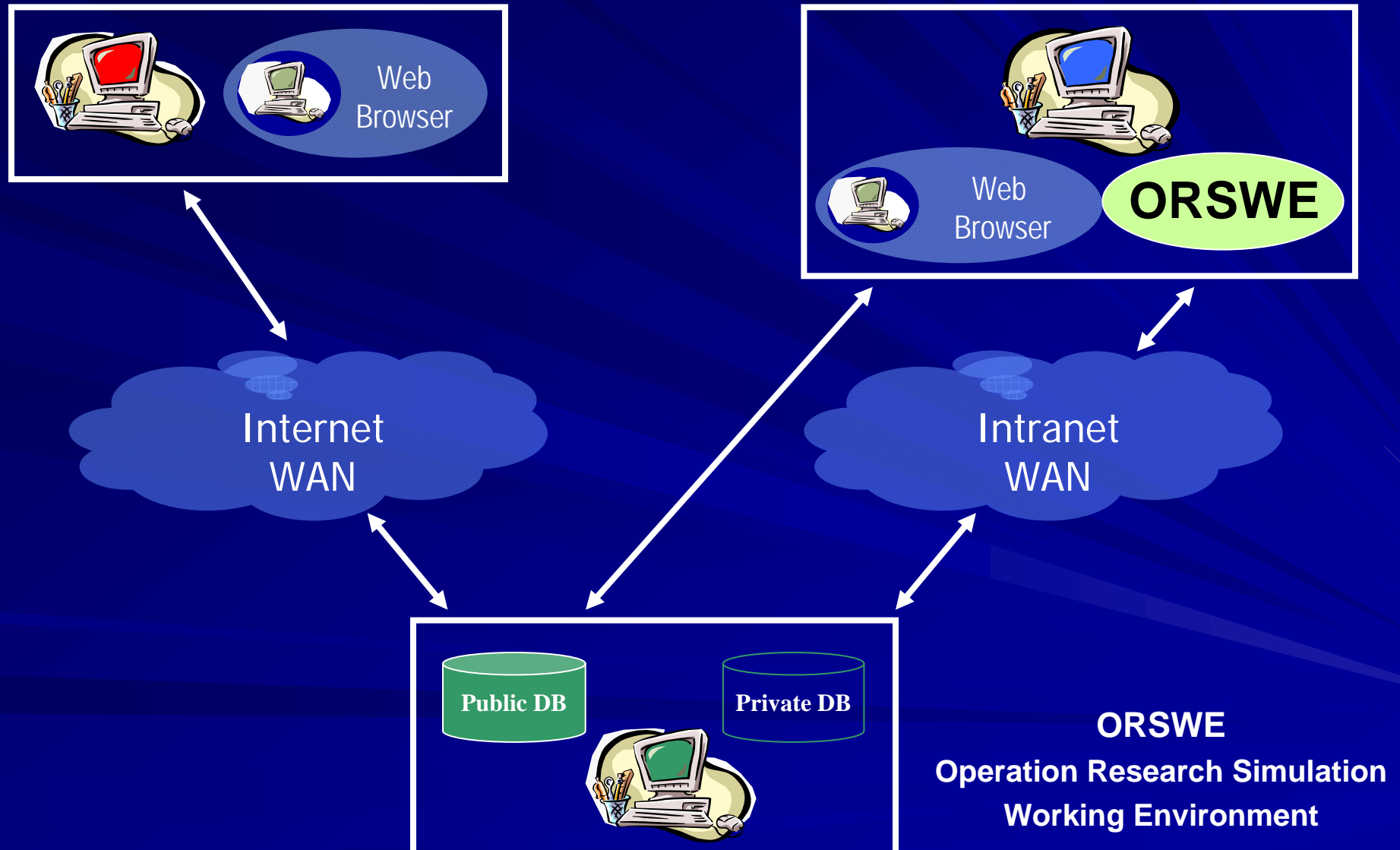
Tools

APPROACH

Repository

ORSWE
Operation Research Simulation
Working Environment

SEDEP ADAPTATION

General Tools

➢ **Repository**
Resources Container and XML management capabilities
➢ **Asset Characterization Tool**
Based on Semantic Web Portal
➢ **Synthetic Environment Management Tool**
It will be a develop guide for experiments and components

OR Analysts Activities

Step 0 ⇨ Analyse User Needs
✧ To analyze the user entries (documents, contracts, etc.)
✧ To search data about existing synthetic environments
✧ To plan the project

Step 1 ⇨ Define User Requirements
✧ To develop a Problem Ontology
✧ To develop the User Requirements
✧ To develop the Base Scenario
✧ To develop the Evaluation Objectives

Step 2 ⇨ Define System Requirements
✧ To define the Objective Evaluation

Step 3 ⇨ Define Experiment Design
✧ To develop the Experiments Design
✧ To elaborate the Test Plan
✧ To design the Objective Evaluation

SEDEP ADAPTATION

General Tools

➤ **Repository**
Resources Container and XML management capabilities
➤ **Asset Characterization Tool**
Based on Semantic Web Portal
➤ **Synthetic Environment Management Tool**
It will be a develop guide for experiments and components

OR Analysts Activities

Step 4 ⇨ Implement Scenario
◇ To Build the Scenario
◇ To implement the Objective Evaluation

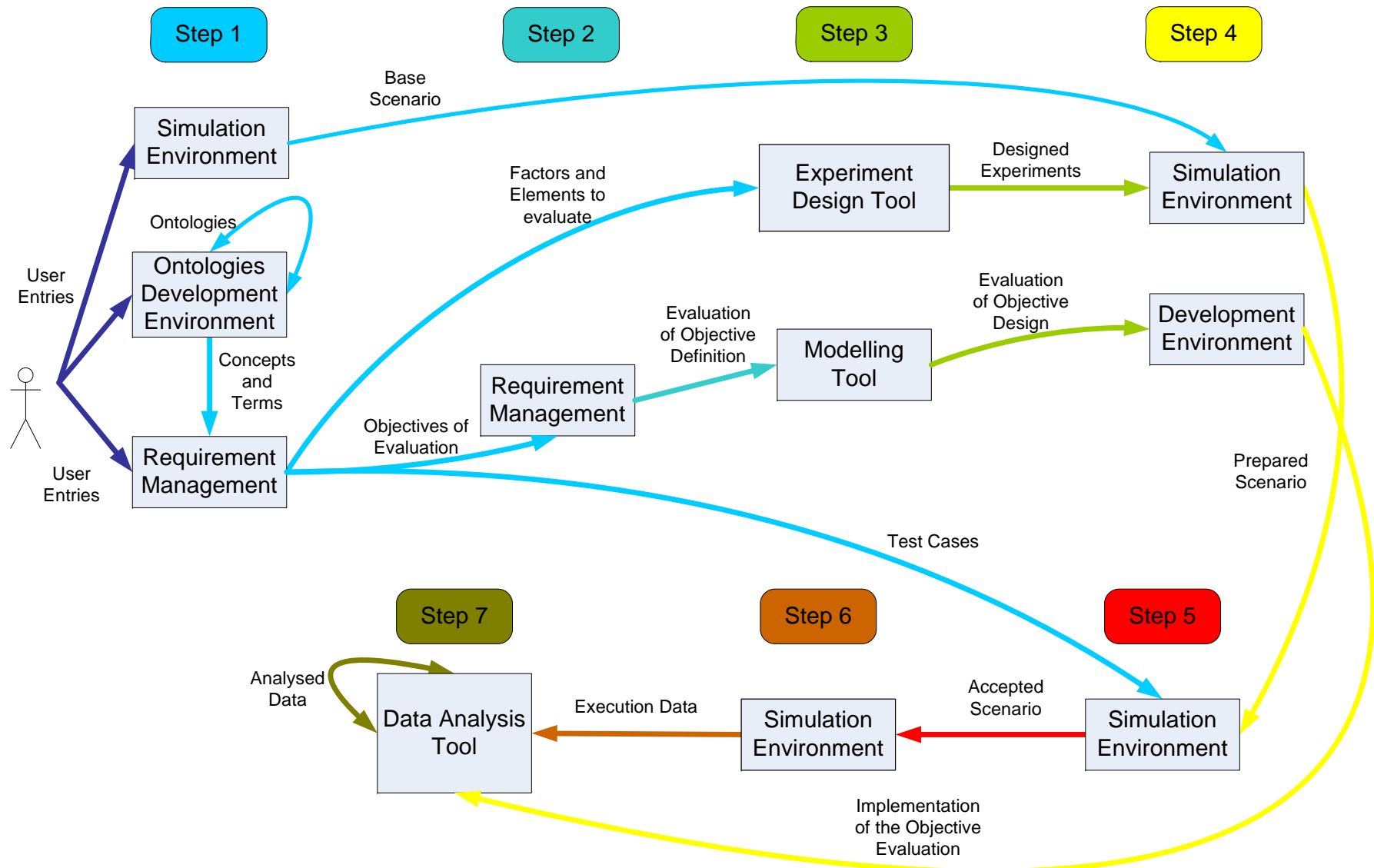**Step 5** ⇨ Test Scenario
◇ Test the Scenario

Step 6 ⇨ Execute Scenario
◇ To execute the Scenario.
◇ To prepare the obtained data.
◇ To collect additional Evaluation data

Step 7 ⇨ Evaluate Scenario
◇ To Analyze data
◇ To evaluate analyzed data

Conclusions

- **To have an Operations Research Simulation Working Environment available to face up new projects is a process transformation within the Spanish Navy Operations Research Laboratory.**

- **A new manner to organize the available resources allows us a faster and cheaper response due to the reusability of models and simulations.**

- **A common repository in which store and share the resources is the core around all the environment will work.**

- **The aim is to expand the results along the whole Ministry of Defense in order to support the simulation community along the complete organization.**

- **The reduction of time and costs through the reusability of resources and experiences is a target of any organization to be competitive and effective.**

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General Tools

➢ Repository

➢ Repository Access Client (RAC)

➢ SE Management Tool (SEMT)

➢ **Asset Characterization Tool (ACT)**

Step 0:
Analyze
User Needs

➢ Goal Editor (GE)

➢ Goal Analyzer (GA)

Step 1:
Define
Federation User
Requirements

➢ User Constraint Requirement Tool (UCRT)

➢ User Scenario Requirement Tool (USRT)

➢ Evaluation Definition Tool (EDT)

➢ Evaluation Definition Selection Tool (EDST)

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Step 2: Define Federation System Requirements

➢ Conceptual Model Tool (CMT)

➢ Conceptual Model Analyser (CMA)

➢ Federation Requirements Tool (FRT)

➢ Evaluation Definition Tool (EDT)

➢ Evaluation Definition Selection Tool (EDST)

Step 3: Design Federation

➢ Federation Composition Tool (FCT)

➢ Federation Composition Tool (FIT)

➢ Scenario Allocation Tool (SAT)

Step 4: Implement Federation

➢ Federation Composition Tool (FCT)

➢ Federation Infrastructure Tool (FIT)

➢ Federation Execution Plan Tool (FEPT)

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**Step 5:
Integrate &
Test Federation**

- Data Distribution Tool (DDT)
- Federate Configuration & Initialization (FC&I)
- Network Configuration Tool (NCT)
- Network Test Tool (NTT)
- Test Navigational Tool (TNT)
- Verification Analysis Tool (VAT)

**Step 6:
Operate
Federation**

- Master Exercise Controller Station (Master-ECS)
- IOS Instructor Operation Station
  - ⇨ Federation Monitoring Control_Tool (FMCT)
  - ⇨ On-Line Federate Configuration Tool (OFCT)
  - ⇨ Instructors Reallocation Tool (IRT)
  - ⇨ Remote Audio Configuration Tool (RACT)

**Step 7:
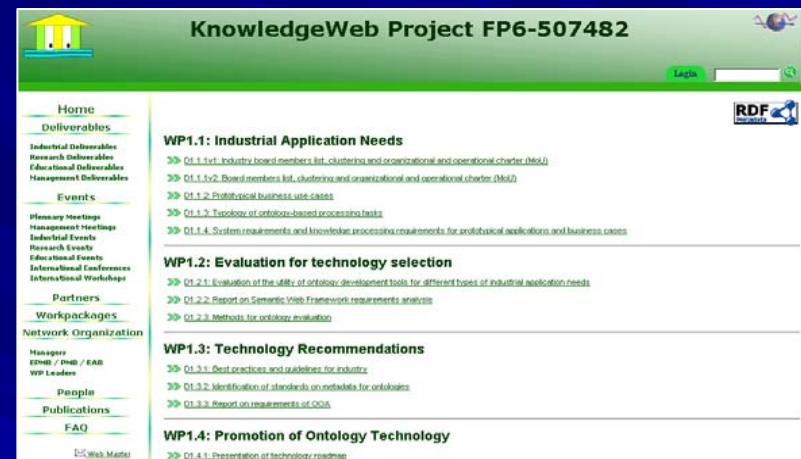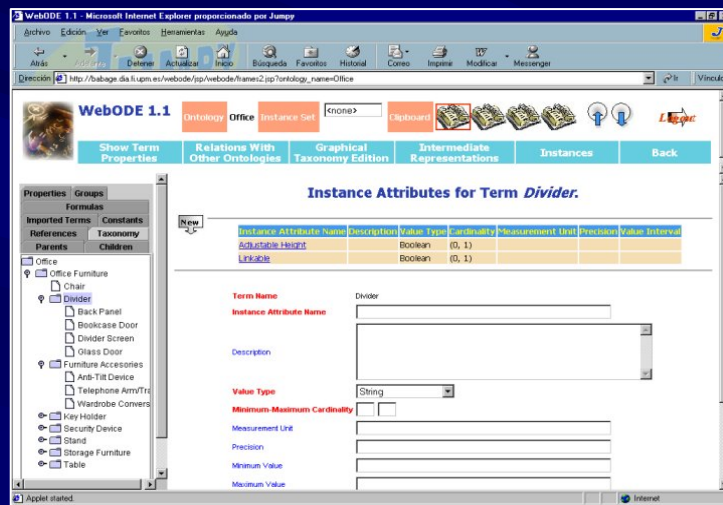Perform
Evaluation**

- Execution Evaluation Tool (EET)

Repository

Repository Public Part – Ontologies based

WebODE

ODESeW

Ontologies

Repository

Repository Private Part – Oracle XML DB